TITLE OF THE INVENTION

OPTICAL RECORDING MEDIUM ON WHICH DATA MAY BE STORED SEAMLESSLY AND METHOD FOR PROCESSING DEFECTIVE AREA WITHIN THE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Application No. 99-14285, filed April 21, 1999, in the Korean Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a writable/rewritable optical recording medium, and more particularly, to an optical recording medium such as a digital versatile disc rewritable (DVD-RW) on which basic recording units are seamlessly connected, and a method of processing a defective area occurring on the recording medium.

2. Description of the Related Art

Conventionally, the management of defects on a writable/rewritable disc is performed only for DVD-random access memory (DVD-RAM). For a defect (primary defect) occurring while a disc is being initialized, a method of slipping replacement is used to slip the defective area without allocating a logical sector number. For a defect (secondary defect) occurring while a disc is being used, a linear replacement technique is used to replace an error correction code (ECC) block including the defective area with a normal ECC block within a spare area.

A DVD-RW, on the other hand, has a recording management data (RMD) area for recording a list of detected defective areas, but a detailed method of detecting defective areas (for example, a certification method) is not defined by any standard. Accordingly, such a method of processing defective areas is needed.

Unlike a DVD-RAM in which basic recording units are discriminated from the others by physical identifiers (PIDs) or a buffer field (a spare area assigned for overcoming the limit caused by accurate control of the spindle motor), in a DVD-RW, basic recording units are

seamlessly recorded without discrimination, so it is necessary to clarify the start point of each basic recording unit. The basic recording unit of a DVD-RAM may be a sector, and the basic recording unit of a DVD-RW may be an ECC block.

The three recording modes of a DVD-RW disc are: disc at once recording mode, overwriting recording mode and incremental recording mode.

When recording in any of these three modes is resumed after having been interrupted, DVD recordables (DVD-Rs) and DVD-RWs, which have the same physical format, employ a linking scheme having 5 bytes of margin for a next recording start point. However, a user data area may be lost when using the linking scheme.

SUMMARY OF THE INVENTION

To solve the above problem, a first object of the present invention is to provide an optical recording medium for storing a data pattern for a defective area in a physically defective area without using a linking scheme wherein basic recording units are seamlessly connected in the optical recording medium.

A second object of the present invention is to provide a method of processing a defective area without loss of a user area and without using a linking scheme in a recording medium in which basic recording units are seamlessly connected.

Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

To achieve the first and other objects, the present invention provides an optical recording medium to which data can be written and rewritten and in which basic recording units are seamlessly connected. Information, which is related to a defective area occurring before user data is recorded on the optical recording medium or while the optical recording medium is being used, is recorded in a predetermined area, and a defective area data pattern is recorded in the defective area during the recording of user data, so that seamless recording of data can be achieved.

To achieve the second and other objects, the present invention provides a method of processing a defective area in an optical recording medium to which data can be written and rewritten and in which basic recording units are seamlessly connected, the processing taking place in a recording and reproduction apparatus. The method includes recording a defective area data pattern in the defective area on the optical recording medium to allow seamless recording of data during recording of user data.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a diagram showing the first dimensional structure of a typical digital versatile disc rewritable (DVD-RW);

FIG. 2 is a diagram showing the contents of a recording management data (RMD) field for storing defective area information in a DVD-RW according to an embodiment the present invention;

FIG. 3A is a diagram showing part of a disc which has undergone certification of defective areas before the disc is used or while the disc is being used;

FIG. 3B is a diagram showing a case in which laser power is lowered to a read power Pr in a defective area only and then increased to a write power Pw; and

FIG. 3C is a diagram showing a case in which the laser power is maintained at the write power Pw even in the defective area according to the embodiment of the present invention shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. 1 illustrates the overall layout of a typical digital versatile disc rewritable (DVD-RW). A DVD-RW is largely divided into two areas with respect to function: a recording (R)-

information area and an information area. The R-information area is divided into a power calibration area (PCA) for adjustment of power and a recording management area (RMA) containing all the information related to recording such as disc recording mode, recording state, optimum power adjustment and border zone information. The information area is divided into a lead-in area, a data recordable area in which a user can write information and a lead-out area, the content of which is not yet defined by the DVD-RW standard.

FIG. 2 shows the structure of recording management data (RMD) fields storing defective area information according to an embodiment of the present invention within an RMA in a DVD-RW which is currently undergoing standardization. Referring to FIG. 2, the RMD comprises 16 sectors. The first sector is assigned as a linking loss area. RMD field 0 stores general information of the disc. RMD field 1 stores optimum power control (OPC) related information. RMD field 2 stores information for user specific data (the content is 00h). RMD field 3 stores border zone information. RMD field 4 stores recording (R) zone information containing recording items. RMD fields 13 and 14 are reserved ones. RMD fields 5 through 12 are assigned for storing information related to defect management and certification, including certification before the disc is used and management of defects occurring while the disc is being used.

In certification before the disc is used, a predetermined recording pattern is written to a data identifier (DID) area and data recordable area, which are located at the beginning portion of each groove track of the disc according to a predetermined rule and then reproduced to detect defective areas in units of a sector or an error correction code (ECC) block. Finally, defect status bitmap information is recorded in the assigned area, RMD fields 5 through 12.

FIG. 3A schematically shows the state of a disc after certification, or a disc which is currently being used. Unlike in a DVD-RAM, in a DVD-RW, the structure of data written to a groove track G is seamless and does not include any physical identifier (PID) nor a buffer field. "L" indicates a land track. When data recording in the DVD-RW is interrupted even for just a moment in the disc at once recording mode, the overwriting recording mode or the incremental recording mode, it is difficult to accurately locate the point at which to restart recording. To solve this problem, conventional technology uses a linking scheme assigning a

linking sector of 5 bytes to serve as a connection range. This method is advantageous in terms of reliability of data but disadvantageous in that the user area is reduced.

In an embodiment of the present invention, during certification or when a user actually records data after the certification, if a defective area (or bad area) 2, as shown in FIG. 3A, corresponding to the defective area information registered in the RMD appears, meaningless dummy data is stored in the defective area without momentary reduction of laser power, data recorded in a predetermined area (e.g., a basic recording unit) preceding or succeeding the defective area is repeatedly recorded in the defective area, or a predetermined data pattern for indicating defective areas is recorded in the defective area. At all times, write power Pw is maintained as shown in FIG. 3C, thereby restraining the occurrence of linking during recording in any of the disc at once recording mode, the overwriting recording mode and the incremental recording mode. The predetermined data pattern may be a recording pattern previously defined by a drive manufacturer. Dummy data, duplication data and a predetermined data pattern can each be referred to as a defective area data pattern.

When a user records data after certification, the sector number of a DID 1 may be the same as the physical sector number used during the certification or may be any logical sector number except for those of bad areas. The DID 1 may be further stored information (e.g., a flag) for discriminating user data from defective area data pattern which is recorded in a corresponding sector.

Conventionally, optical power emitted from a light source such as a laser is lowered to a power not influencing the recording, for example, less that or equal to a read power Pr, causing a time delay in the recording process corresponding to the defective area. This is shown in FIG. 3B for the case of the defective area 2 first shown in FIG. 3A. In this case, when a DID 1 next to the defective area 2 is detected and recording is resumed thereafter, a time shift occurs at point 3 at which recording is recommenced, so that the point 3 at which recording is actually recommenced cannot exactly match with a recording start position which is indicated by a land pre-pit (LPP) including physical position information. In the case of a DVD-RW, data can be written only to a groove track, and pre-pit information indicating a physical ECC block number is written to a land track.

To solve these problems, the embodiment of the present invention described above records a defective area data pattern in a defective area and does not lower write power in the defective area, as shown in FIG. 3C. In another embodiment, when laser power is lowered in a defective area and data is recorded in an adjacent non-defective area after slipping the defective area in an incremental recording mode, a wobble signal having a fixed frequency at the track pitch or some other reference signal related to time is used, thereby minimizing the problem of the time shift. In other words, an accurate recording start point can be exactly detected by counting wobble signals or reference signals.

In the above preferred embodiments of the present invention, the DVD-RW is taken as an example, but the present invention can be adopted in a DVD recordable (DVD-R) or any recording medium in which the basic recording units are seamlessly connected. The present invention can also be effectively adopted in a disc used in a disc at once recording mode, an overwriting recording mode and an incremental recording mode.

According to the present invention, during the certification or use of a recording medium having seamlessly connected basic recording units, a predetermined pattern having no relation with user data is recorded in a defective area instead of slipping the defective area, thereby preventing linking caused by the interruption of data recording. Consequently, the present invention ensures a maximum user area.

In addition, even in the case of slipping a defective area after lowering laser power in the defective area and resuming data recording in an adjacent non-defective area, the present invention uses a reproduced wobble signal or other reference signal to detect the exact recording restart point, thereby improving the reliability of the system.

Although a few preferred embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.